Amendments to the Claims: This listing of claims will replace all prior versions, and listings, of claims in the application

Listing of Claims

1. (Currently Amended) A field emission type electron source device comprising:

a field emission electron source portion including an extraction electrode provided on a p-type silicon substrate via an insulating film and having an opening portion at a position corresponding to a region where a cathode is provided; and a cathode portion provided on the p-type silicon substrate and at a position corresponding to the opening portion of the extraction electrode; and

an n-channel field effect transistor portion provided on the p-type silicon substrate, corresponding to the field emission electron source portion,

wherein:

the field emission electron source portion is provided in a drain region of the field effect transistor portion; and a control voltage is applied to a gate electrode of the field effect transistor portion to control a field emission current from the field emission electron source portion~~, wherein the gate electrode is positioned lower than the extraction electrode~~;

the drain region includes different impurity elements and includes at least two wells having different impurity concentrations having symmetrical impurity distributions; and

of the at least two wells, one well having a low impurity concentration is provided around a circumference of the other well having a higher impurity concentration.

2. (Original) A field emission type electron source device according to claim 1, wherein as the impurity elements the drain region includes at least two n-type impurity elements having different thermal diffusion speeds in the silicon substrate.

3. (Original) A field emission type electron source device according to claim 1, wherein as the impurity elements, the drain region includes phosphorous, having a fast thermal diffusion speed and arsenic, having a slow thermal diffusion speed in the silicon substrate.

4. (Currently Amended) A field emission type electron source device comprising:

a field emission electron source portion including an extraction electrode provided on a p-type silicon substrate via an insulating film and having an opening portion at a position corresponding to a region where a cathode is provided; and a cathode portion provided on the p-type silicon substrate and at a position corresponding to the opening portion of the extraction electrode; and

an n-channel field effect transistor portion provided on the p-type silicon substrate, corresponding to the field emission electron source portion,

wherein:

the field emission electron source portion is provided in a drain region of the field effect transistor portion; and a control voltage is applied to a gate electrode of the field effect transistor portion to control a field emission current from the field emission electron source portion;

the gate electrode of the field effect transistor portion has a shape such that a portion of the gate electrode nearer the drain region has a total width wider than a total width of a portion of the source electrode nearer the source region; and a part of the gate electrode is provided in such a manner as to cover an end of the drain region~~; and the gate electrode is positioned lower than the extraction electrode~~.

5. (Currently Amended) A field emission type electron source device comprising:

a field emission electron source portion including an extraction electrode provided on a p-type silicon substrate via a first insulating film and having an opening portion at a position corresponding to a region where a cathode is provided; and a cathode portion provided on the p-type silicon substrate and at a position corresponding to the opening portion of the extraction electrode; and

an n-channel field effect transistor portion provided on the p-type silicon substrate, corresponding to the field emission electron source portion,

wherein:

the field emission electron source portion is provided in a drain region of the field effect transistor portion; and a control voltage is applied to a gate electrode of the field effect transistor portion to control a field emission current from the field emission electron source portion~~, wherein the gate electrode is positioned lower than the extraction electrode~~;

the drain region including at least two wells having different impurity concentrations, a first of the at least two wells being provided around a circumference of the second of the at least two wells;

a gate insulating film is provided between the gate electrode of the field effect transistor and the p-type silicon substrate; the gate insulating film ~~includes a~~ is a film thinner than the first insulating film, the first insulating film being provided between the extraction electrode and the p-type silicon substrate; and the gate ~~insulating film~~ electrode is buried with the first insulating film.

6. (Original) A field emission type electron source device according to claim 5, wherein the gate insulating film includes a thermally oxidized silicon film, provided by a step of thermal oxidization for sharpening treatment for sharpening a tip of the cathode portion of the field emission electron source portion.

7. (Previously Presented) A field emission type electron source device comprising:

a field emission electron source portion including an extraction electrode provided on a p-type silicon substrate via an insulating film and having an opening portion at a position corresponding to a region where a cathode is provided; and a cathode portion provided on the p-type silicon substrate and at a position corresponding to the opening portion of the extraction electrode; and

an n–channel field effect transistor portion provided on the p-type silicon substrate, corresponding to the field emission electrode source portion,

wherein:

the field emission electron source portion is provided in a drain region of the field effect transistor portion; and a control voltage is applied to a gate electrode of the field effect transistor portion to control a field emission current from the field emission electron source portion;

the field emission type electron source device further comprises a shield electrode made of the same material of that of the gate electrode of the field effect transistor portion, and the shield electrode is provided in such a manner as to cover a channel region of the field effect transistor portion which is not covered with the gate electrode, while the potential of said shield electrode is made to be equal to that of the substrate.

8. (Cancelled)

9. (Original) A field emission type electron source device comprising:

a field emission electron source portion including an extraction electrode provided on a p-type silicon substrate via an insulating film and having an opening portion

at a position corresponding to a region where a cathode is provided; and a cathode portion provided on the p-type silicon substrate and at a position corresponding to the opening portion of the extraction electrode; and

an n-channel field effect transistor portion provided on the p-type silicon substrate, corresponding to the field emission electron source portion,

wherein:

the field emission electron source portion is provided in a drain region of the field effect transistor portion; and a control voltage is applied to a gate electrode of the field effect transistor portion to control a field emission current from the field emission electron source portion;

the drain region of the field effect transistor portion is provided in a source region of the field effect transistor portion in such a way to be surrounded by the source region; and

the gate electrode of the field effect transistor portion is positioned symmetrical in a plane with respect to the cathode portion of the field emission electron source portion.

10 (Original) A field emission type electron source device according to claim 9, wherein the drain region includes a p-type conductive layer.

11. (Original) A field emission type electron source device according to claim 9, wherein an outer portion of the drain region contacts the channel region of the field effect transistor portion; and the outer region of the drain region and an inner portion of the source region have a shape of concentric circles.

12. (Original) A field emission type electron source device according to claim 9, wherein at least a part of the gate electrode provided between the source region and the drain region has a shape of a symmetrical circular arc.

13 (Original) A field emission type electron source device according to claim 9, wherein first voltage Vex applied to the extraction electrode of the field emission electron source portion and second voltage Vg applied to the gate electrode of the field effect transistor portion have a relationship such that $Vg<Vex$.

14. (Previously Presented) A field emission type electron source device according to claim 1, wherein the extraction electrode is provided in a region above the drain region and away from an interface between regions of different impurity concentrations.

15. (Previously Presented) A field emission type electron source device according to claim 4, wherein the extraction electrode is provided in a region above the drain region and away from an interface between regions of different impurity concentrations.

16. (Previously Presented) A field emission type electron source device according to claim 5, wherein the extraction electrode is provided in a region above the drain region and away from an interface between regions of different impurity concentrations.

17. (Previously Presented) A field emission type electron source device according to claim 7, wherein the extraction electrode is provided in a region above the drain region and away from an interface between regions of different impurity concentrations.

18. (Previously Presented) A field emission type electron source device comprising:

a field emission electron source portion including an extraction electrode provided on a p-type silicon substrate via an insulating film and having an opening portion at a position corresponding to a region where a cathode is provided; and a cathode portion provided on the p-type silicon substrate and at a position corresponding to the opening portion of the extraction electrode; and

an n-channel field effect transistor portion provided on the p-type silicon substrate, corresponding to the field emission electron source portion,

wherein:

the field emission electron source portion is provided in a drain region of the field effect transistor portion; and a control voltage is applied to a gate electrode of the field effect

transistor portion to control a field emission current from the field emission electron source portion;

the drain region of the field effect transistor portion is provided in a source region of the field effect transistor portion in such a way to be surrounded by the source region; and

the gate electrode of the field effect transistor portion is positioned symmetrical in a plane with respect to the cathode portion of the field emission electron source portion and lower than the extraction electrode.

19. (Previously Presented) A field emission type electron source device according to claim 18, wherein the drain region includes a p-type conductive layer.

20. (Previously Presented) A field emission type electron source device according to claim 18, wherein an outer portion of the drain region contacts the channel region of the field effect transistor portion; and the outer region of the drain region and an inner portion of the source region have a shape of concentric circles.

21. (Previously Presented) A field emission type electron source device according to claim 18, wherein at least a part of the gate electrode provided between the source region and the drain region has a shape of a symmetrical circular arc.

22. (Previously Presented) A field emission type electron source device according to claim 18, wherein first voltage Vex applied to the extraction electrode of the field emission electron source portion and second voltage Vg applied to the gate electrode of the field effect transistor portion have a relationship such that $Vg<Vex$.